From glowbugs@theporch.com Sun Sep 22 02:40:52 1996
Return-Path: <glowbugs@theporch.com>
Received: from uro (localhost.theporch.com [127.0.0.1]) by uro.theporch.com (8.8.Beta.6/AUX-3.1.1) with SMTP id CAA12729; Sun, 22 Sep 1996 02:35:29 -0500 (CDT)
Date: Sun, 22 Sep 1996 02:35:29 -0500 (CDT)
Message-Id: <199609220735.CAA12729@uro.theporch.com>
Errors-To: ws4s@midtenn.net
Reply-To: glowbugs@theporch.com
Originator: glowbugs@theporch.com
Sender: glowbugs@theporch.com
Precedence: bulk
From: glowbugs@theporch.com
To: Multiple recipients of list <glowbugs@theporch.com>
Subject: GLOWBUGS digest 298
X-Listprocessor-Version: 6.0c -- ListProcessor by Anastasios Kotsikonas
X-Comment: Please send list server requests to listproc@theporch.com
Status: O

GLOWBUGS Digest 298

Topics covered in this issue include:

Date: Fri, 20 Sep 1996 22:35:06 -1000
From: Jeffrey Herman <jherman@hawaii.edu>
To: Jeff Duntemann <jeffd@coriolis.com>
Subject: Re: Making your own IF transformers
Message-ID: <Pine.GSO.3.93.960920222810.7112A-100000@uhunix5>

On Fri, 20 Sep 1996, Jeff Duntemann wrote:
>   My first transmitter was
> homebrew and a total mess--but I worked 12 states with it before a local
> club gently encouraged me to retire it in favor of something that was NOT
> 10% AM modulated by 60 cycle hum.

It must have sounded lovely through a rcvr's BFO! MCW xmissions on the
maritime band of 500kc reminded me of someone sending Morse on a

piano keyboard. Beautiful! All 10kc of it...

Jeff KH2PZ / KH6

Date: Sat, 21 Sep 1996 12:30:33 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
To: glowbugs@theporch.com
Subject: Roy Morgan -- I lost yer snailmail address de NA4G
Message-ID: <9609211630.AA101002@csemail.cropsci.ncsu.edu>

Roy Morgan --- I lost your snailmail address. Can you resend via email.
TNX DE NA4G/Bob
(sorry for bandwidth)

Date: Sat, 21 Sep 1996 16:34:16 -0400
From: Lrware@aol.com
To: glowbugs@theporch.com
Subject: mu-metal & shielding, WAS: Re: Making your own IF transformers <long>
Message-ID: <960921163416_107416611@emout08.mail.aol.com>

It was posted:

>What is mu-metal? And does aluminum work better than
>copper for magnetic shielding?

In a related message:
> > I've not heard of mu-metal; no idea whether it's aluminum based or what.

<snip>
> Mu-metal was the material used for shields on CRT's (scope tubes) to
> reduce effects of magnetic fields. I don't think it would be a benefit
> on IF transformers.
>
I may have started this whaen I suggested mu-metal to Jeff for
low freq. IF cans...

NOTE* "mu-metal" and "Amumetal" are both brand names for
80% nickel-iron alloys designed for magnetic shielding. They
are spec'd by MIL-N-14411C, composition 1 and
ASTM A753-78, type 4. For this long winded post, I'm going to
use the most common term: mu-metal.

So, from the AMUNEAL Manufacturing Corp. some info from:

"The Definitive Guide to Magnetic Shielding"
<snip>
Magnetic shielding strategies which are based on the interactions between AC and DC magnetic fields and high permeability materials are passive shielding strategies. in order to understand how passive shields operate the following terms must be defined.

Magnetic Field Strength (H)
The "H" field describes the intensity of a magnetic field in free space. The field strength, measured in Oersteds (Oe) depends on the intensity from the source and the distance from the source at which it is measured.

Magnetic Flux Density (B)
The "B" field, describes the concentration of magnetic lines of force per square centimer in a material.
Flux density is measured in Gauss (G) and depends on the distance of a material from the magnetic source and the materials permeability.

Material Permeability (u)
Permeability, Greek symbol mu, refers to a materials ability to conduct magnetic lines of flux.
The more conductive to magnetic fields the higher it permeability. u = B/H which simply states that the permeability of a material can be determed by measuring the magnetic field strength (H) at a point in free space and then measuring the flux density (B) at that point after insertation of a material.

Saturation
Saturation is the limiting point of a materials ability to conduct magnetic lines of flux.
It is defined by the maximum number of magnetic flux lines that can be conducted through each square centimeter of material.
Materials with the highest permeabilities have correspondingly low saturation points.
A saturated material can no longer function as a proper shield.

Attenuation
Attenuation of a given shield is a ratio used to measure its effectiveness. This ratio is expressed as the field strengh at a given point vs the resulting field strength with a shield in place.

OK, we have defined some terms, now we can move on... :-)

Shielding Strategies

1) The easiest though not always practical method is to use distance. The amount of attenuation or field reduction due to spacing is typically the inverse of the distance squared.
2) Flux shunting for DC: High permeability materials can be used to gain the desired effects. All magnetic shielding in DC applications and a percentage of shielding in AC applications is the result of the concentration and redirection of the fields. This is called Flux Shunting. Flux shunting is based on the use of shields made from high permeability materials. These shields are designed to either contain the object you are protecting, or the source itself. Magnetic fields will follow the path of least resistance. a high permeability material such as mu-metal or Amumetal offers them this path. A flux shunting shield operates by attracting, concentrating and redirecting the fields in its proximity.
3) Eddy Current Shielding for AC Magnetic Fields:
When we move on to AC shielding of magnetic fields the dynamic becomes somewhat different. In shielding AC magnetic fields, as the frequency increases, the contribution of the flux shunting decreases when determining a shields overall effectiveness.
When electromagnetic waves encounter a highly permeable and conductive material a phenomenon called "Eddy Current" or "Induced Current Shielding" occurs. The waves cause small circular electrical currents, called Eddy Currents, to form at the materials surface. These eddy currents produce magnetic fields perpendicular to themselves in a direction which opposes the incoming fields. When the magnetic fields leaving the material meet the incoming source fields they cancel one another out and provide very effective shielding. The higher the frequency of the incoming fields, the better the shielding.

Magnetic shield design issues:

1) Geometry:
Most magnetic shielding formulas and priniciples are based on the optimal geometry of a sphere or an infinitely long cylinder. As these shapes are not practical in the real world, we must subjectively degrade values for a materials permeability based on how much a given shields geometry differs from that of a sphere or infinitely long cylinder.
2) Shape:
Magnetic flux lines don't like to turn 90 degrees; therefore, rounded shields such as some IF cans are better at redirecting the flux than square shields. Similarly, gentle radii are better than sharp turnes in containing flux that is already

entrapped. It is important to keep the geometry of a shield simple, always having a low reluctance path in mind.
3) Size:
The smaller the effective radius of a shield, the better its performance. Therefore, it should always be a goal to design a shield that will envelop the component or space you are attemping to shield as closely as possable.
4) Continuity:
it is necessary to insure magnetic continuity or contact, whenever a shield is constructed from two or more pieces. This includes lids, covers, corners, seams, etc. Maintaining continuity insures that the magnetic flux will be able to continue along a low reluctance path thus maintaining shielding performance.
5) Closure:
When possable, a shield should be closed on all sides. This configuration often best approximates a sphere, and creates a closed magnetic circuit.
6) Length to Diameter Ratio:
For shields with open ends, the ratio of the shields diameter to its length is critical. By increasing the length of a shield while maintaining its diameter, we can approximate an infinitely long cylinder. This improves shielding performance.
7) Openings:
If a shield must have holes, then the diameter of those openings becomes very important. Magnetic fields can travel into any opening a distance equal to five times the diameter of the opening.
8) Multi-Layer Shields:
In some cases a single layer shield cannot provide either the level of attenuation or saturation protection required. in this case multi-layer of nested shields must be used.

Shielding Formula for single layer device:

A = (u/4)[1- (RI (sq) / RO (sq))] +1

(thats as close as I can get in ASCII)

A = Attenuation @ DC
u = Permeability value of material
RI = Inside Radius
RO = Outside Radius

The design of a magnetic shield begins with the proper material selection. Thus we move on to the different shielding characteristics of some standard materials...

Magnetic shielding materials are chosen for characteristics in respect to permeability and saturation.
As permeability increases in magnetic shielding, the saturation level decreases. Therefore materials with very high permeability, such as mu-metal have the lowest saturation values. A saturated shield is a poor attenuator, thus we must select a material with adequate saturation characteristics to withstand a given source field while providing the required attenuation due to the material's permeability.

Material:	Saturation Gauss	Max. Permeability
mu-metal	8000	400,000
mu-nickel	15,000	150,000
low carbon steel	22,000	4,000

(Sorry, but I couldn't find the numbers for copper :-)

Now comes the kicker....

Hydrogen Annealing:
Materials like mu-metal require a special annealing process. Shielding materials reach their optimum permeabilities when they undergo this heat treating process. The annealing should take place AFTER all fabrication has been completed. Any work done on the material after annealing will degrade the materials performance.

mu-metals standard annealing cycle consists of a dry hydrogen atmosphere with a dew point below -60F, heated to 2150F for four hours and then cooled to room temperature at a rate of 6-9F per minute.
This process removes the carbon and other trace elements from the material and relieves the mechanical stresses due to processing and fabrication. This allows the crystalline structure of the nickel in the material to expand. This newly formed nickel structure creates a low reluctance path for magnetic fields to follow, thus increasing the materials permeability.
after the annealing cycle it is critical to avoid any rough handling of the material as it is extremely sensitive to shock and vibration. The crystalline grain structure of nickel is fragile and any disturbance begins to destroy the materials permeability.

OK, thats more than enough for one sitting.... <whew!>
Anybody not yet bored to death about mu-metal?
-Larry Ware
lrware@aol.com

Date: Sat, 21 Sep 1996 14:52:40 -0700
From: anthonys@ix.netcom.com (Anthony Severdia)
To: Lrware@aol.com
Cc: glowbugs@theporch.com
Subject: Re: mu-metal & shielding, WAS: Re: Making your own IF transformers <long>
Message-ID: <199609212152.OAA03215@dfw-ix9.ix.netcom.com>

~
Larry Ware wrote:-
>
    (all the early details clipped for brevity)
>
>Now comes the kicker....
>
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>they undergo this heat treating process. The annealing should
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>increasing the materials permeability.
>after the annealing cycle it is critical to avoid any rough handling
>of the material as it is extremely sensitive to shock and vibration.
>The crystalline grain structure of nickel is fragile and any

>disturbance begins to destroy the materials permeability.

This last description is essential for mu-metal to reach maximal effectivness. I'm not an expert but I do know the processes that were (are?) required for critical shielding of heads in professional analor magnetic tape recorder design. At this moment, I think that such careful measures are not required for receiver IF cans, and is probably the reason why these cans are typically aluminum shielded.

>
>OK, thats more than enough for one sitting.... <whew!>
>Anybody not yet bored to death about mu-metal?
>-Larry Ware
>lrware@aol.com

Not at all, Larry! It is very informative and much appreciated.

-=Tony=- W6ANV

End of GLOWBUGS Digest 298
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